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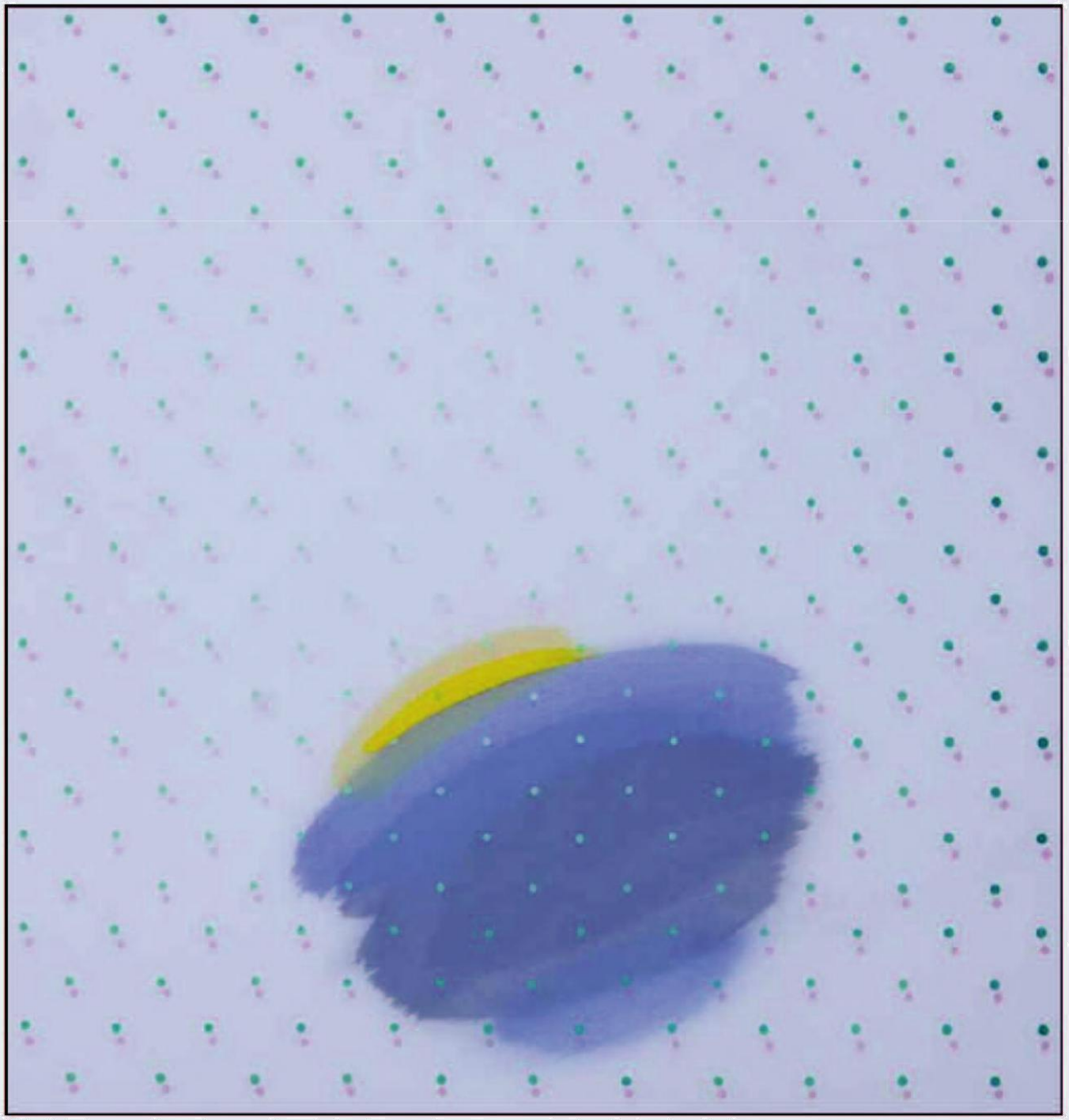

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Importance of Visualization in Math Problems at the Universities

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ABSTRACT

The small desire to learn mathematics among students, difficulties to master the material can be solved if we approach their visual representation. Mathematical books that contain only problems without their visual representation are hardly acceptable by students. So, demonstration and visualization play an important role in the teaching process of the subject mathematics in primary, secondary schools and universities. They make the teaching content interesting and accessible, especially when technical devices are used.

This paper is the beginning of the research in which we will have two groups of students, at two Universities: Mother Teresa Skopje and Goce Delchev Stip, which will process mathematical content (algebra, geometry, analysis) in two different ways (some with GeoGebra and on a computer, and others without visualization and GeoGebra) then will be done testing, the results will be compared and a conclusion will be drawn. For this purpose, a student questionnaire was made to see what their thinking about learning mathematics with visualization in both University and the results from questionnaire are given in this paper. Complete results of a whole research will be published additionally.

The software we chose to be GeoGebra because it is easy for use and is offered free of charge. It is dynamic mathematics software, supporting science, technology, engineering and mathematics education.

Keywords: *Mathematics, GeoGebra, Visualization.*

Introduction

GeoGebra is an interactive mathematics software program for learning and teaching mathematics and science from primary school up to university level. Constructions can be made with points, vectors, segments, lines, polygons, conic sections, inequalities, implicit polynomials and functions. All of them can be changed dynamically afterwards.

GeoGebra was created by Markus Hohenwarter in 2001/2002 as part of his master's thesis in mathematics education and computer science at the University of Salzburg in Austria. During the past years, GeoGebra has developed into an open- source project.

The history of visualization within mathematics education is a long one and the role of visualization in mathematics learning has been the subject of much research.

Visualization is the ability, the process and the product of creation, interpretation, use of and reflection upon pictures, images, diagrams, in our minds, on paper or with technological tools, with the purpose of depicting and communicating information, thinking about and developing previously unknown ideas and advancing understandings. Visualization, as both the product and the process of creation, interpretation and reflection upon pictures and images, is gaining increased visibility in mathematics and mathematics education.

Visualization is important for all sciences and can be applied in all sciences. The goal is to make it easier to understand the problems students and researchers face in order to solve them in an easier way.

The history of visualization within mathematics education is a long one. Since the beginning of the 1980s mathematics educators are interested in the practical challenges of teaching visualization, in visualization of mathematics as exhibits in school or aligned with educational psychology and are looking for theoretical frameworks.

In [2] the purpose of paper is to provide pedagogical strategies and discuss ideas about teaching mathematics using GeoGebra that promote effective use of visualization in a technology-integrated dynamic environment. The author describes his work with prospective secondary mathematics teachers enrolled in a methods course. The results of the study revealed that their perspectives on teaching and learning mathematics with technology were enriched as they worked individually and in small groups to develop and lessons with GeoGebra, suggesting that creating a collaborative environment for our prospective teachers is an important as incorporating dynamic mathematics software into our teacher education courses. In book [5] an introduction to GeoGebra is given. Paper [8] is an attempt to define visualization

and to analyze, exemplify and reflect upon the many different and rich roles it can and should play in the learning and the doing of mathematics. At the same time, the limitations and possible sources of difficulties visualization may pose for students and teachers are considered. In [7] you can find a tutorial on how to use GeoGebra in more areas of mathematics.

Visualization in Mathematics

Mathematics teachers from two universities: University “Goce Delcev”- Stip (UGD) Faculty of natural and technical sciences in Kavadarci and “Mother Teresa” University - Skopje (MTU) at classes in lectures and exercises in mathematical subjects, a distinction of hours worked on mathematical topics using computers and visualization of problems. The goal was students to see the difference when teaching is complemented by software for visualizing problems, which are, solve. Here are some of the examples that were considered at those math lessons:

In the first example we had illustration with GeoGebra how two functions can be adding, subtracting, dividing and multiplying, and also were given the value of functions at given point. This example was taken from https://www.geogebra.org/m/NGgtXByQ.

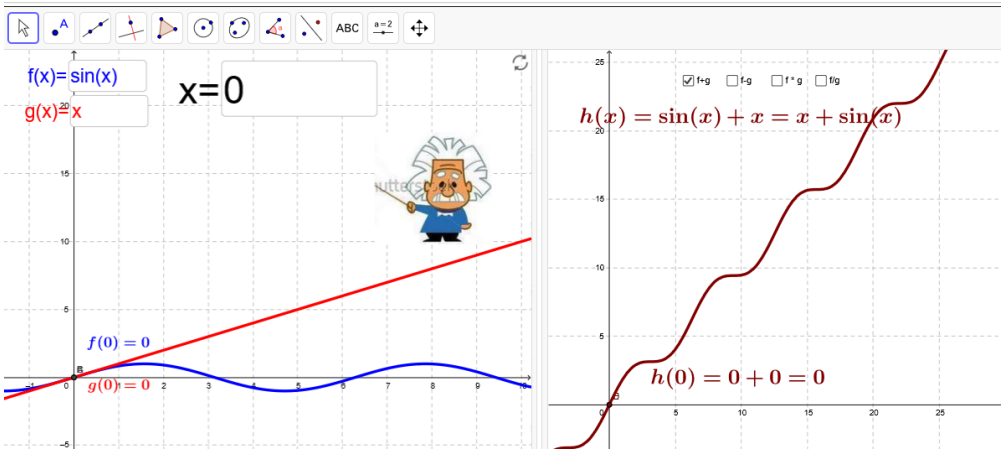


Figure 1.

It the second example taken from https://www.geogebra.org/m/YCqpX8dt we had Cone and Cylinder by revolution. Here was seen how the Cone and the Cylinder change with the change of radius and rotation angle.

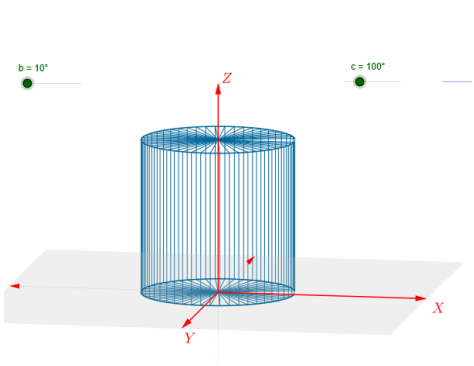


Figure 2.

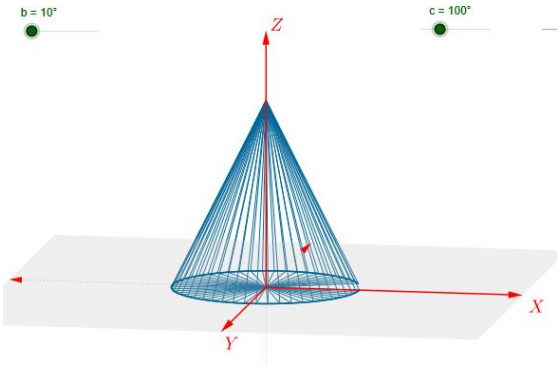


Figure 3.

In the last example we visualize an example from the set of complex numbers, where we was seen complex number operations and their geometric interpretations. This example was taken from https://www.geogebra.org/m/nxBcCV6T.

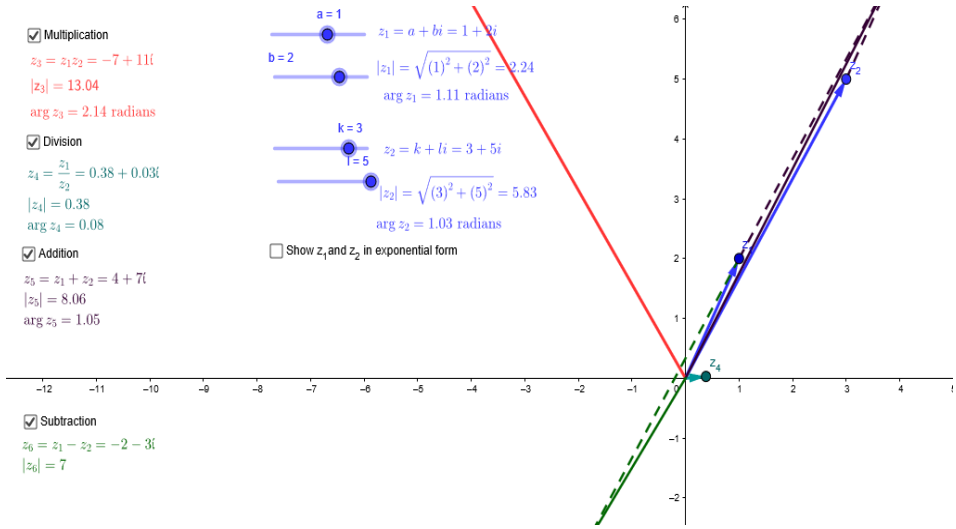


Figure 4.

Then, the teachers decided to make a questionnaire which should be solved by the students who followed the classes in which the visualization software was studied in order to determine whether their motivation for learning mathematics changes if software and computers are used for visualize the problems which they need to solve.

The questioned students were the first year from two universities: UGD Faculty of natural and technical sciences in Kavadarci and MTU Skopje. Students had the task of completing a questionnaire consisting of 10 questions related to the visualization of mathematical problems. The goal is to see student thinking. Their thinking will help us to conclude on what in future mathematical textbooks we should write, and to recommend to other mathematics teachers to write.

Among the interviewed students there are those with very good results in mathematics, but there are also students who have achieved poor results. The situation is the same on both

universities. The students had 30 minutes to answer the questionnaire. Both students group completed the questionnaire in less than 20 minutes.

The results of the testing will be analyzed, the results obtained from the two universities will be compared, and finally a conclusion will be drawn.

Next, student questionnaire follows:

Student questionnaire

1. Do you want to study mathematics?

2. Do you know how a mathematical problem can be visually presented?

3. Have you seen mathematical books in which are visually present mathematical problems with software for visualization explained in that book.?

4. Do you think that learning will be easier if you learn from mathematical books in which the mathematical problems are visually presented?

5. Do you know any software that can help visualize mathematical problems?

6. Do you want to study mathematics with visualization?

7. Do you think that if mathematical problems are visually presented, the interest in mathematics among students will be greater?

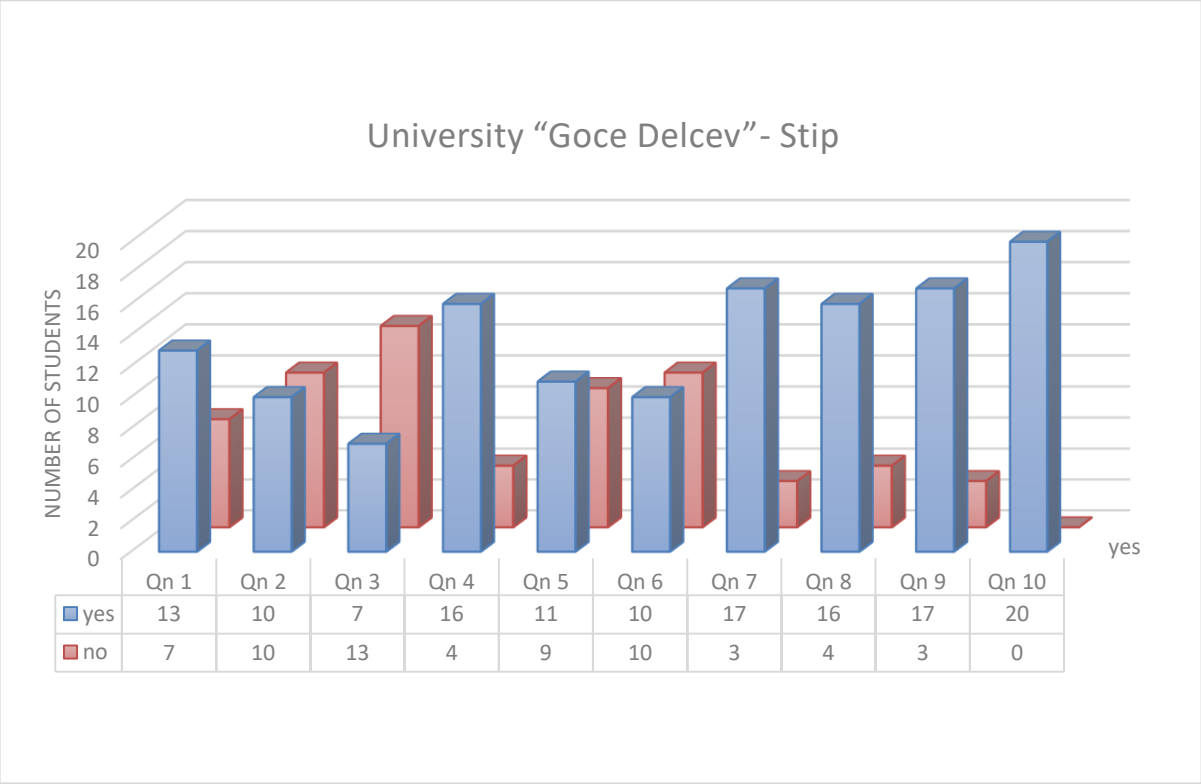
8. Do you want to have more books in which mathematical problems will be visually presented with software for visualization and explanation who to work in it?

9. Do you want to learn some software that can help you to visualize mathematical problems?

10. Do you think that the visualization of mathematical problems will improve your results in mathematics?

The data was collected by a sample of 40 students, 20 of University “Goce Delcev”- Stip (UGD) Faculty of natural and technical sciences that is the group of students who studying in Kavadarci and 20 from students of “Mother Teresa” University - Skopje (MTU).

Students' results from Faculty of natural and technical sciences University “Goce Delcev”- Stip for student questionnaire are:



	Qn 1	Qn 2	Qn 3	Qn 4	Qn 5	Qn 6	Qn 7	Qn 8	Qn 9	Qn 10
yes	13	10	7	16	11	10	17	16	17	20
no	7	10	13	4	9	10	3	4	3	0

Table 1

Students' results from “Mother Teresa” University - Skopje for student questionnaire are:

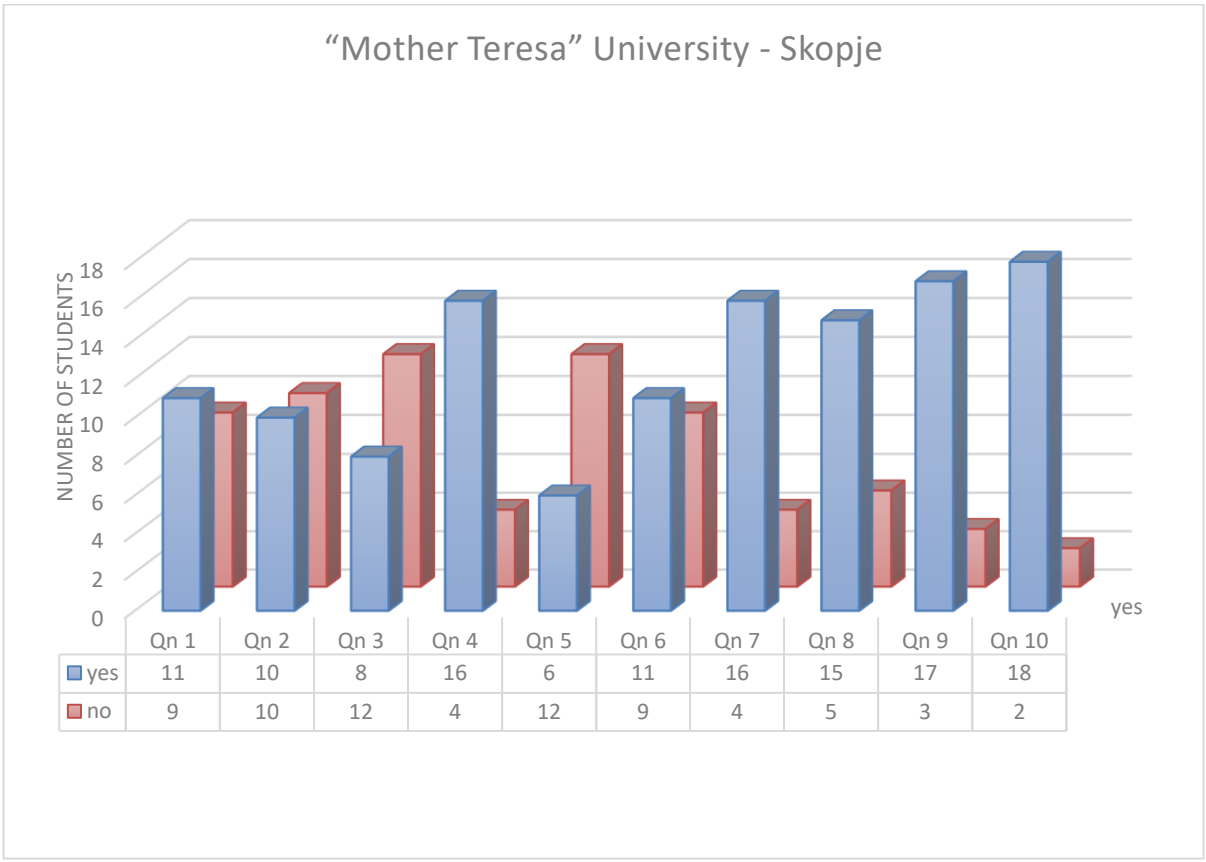


Table 2

From Table 1 it can be seen that most of a students from University “Goce Delcev”- Stip Faculty of natural and technical sciences Kavadarci do not have much interest in learning mathematics. They do not encounter many mathematical books in which problems are visually presented with some software for visualization explained in that book. They want to study mathematics with visualization and it would be good to provide visualization software in the mathematics curriculum. Our proposal is the GeoGebra software. Some students know how to use it, and others can easily overcome it. Students believe that the visualization of mathematical problems can improve their weak mathematical results. Therefore, their opinion should be taken into consideration and changes made in order to improve the results in mathematical subjects.

Very similar are the results of a “Mother Teresa” University - Skopje i.e. from Table 2. They also not have much interest in learning mathematics. The opinion of these students coincides with the opinion of UGD students. Their opinion is that they need to visualize problems in mathematical problems so that they can be easily understood by students and thus improve their results.

Conclusion

The importance of visualization in general for all problems in all areas is great. Any problem would be resolved more quickly, simpler and easier with visualization. Of course, this also applies to mathematical problems. Therefore, visualization would also help to raise the desire to learn mathematics. This would increase the number of students at the technical faculties and there would no longer be a deficient staff in the technical sciences.

From the analysis above, we can say that some measures must be taken to increase students' interest in mathematics. Our proposal is the visualization of problems, introduction of visualization software in the curriculum, introducing students to the importance of mathematics and its extensive application. So, GeoGebra software must be use from all students and must to apply it.

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